

Long-range interactions in Sznajd consensus model

Christian Schulze

Institute for Theoretical Physics, Cologne University
D-50923 Köln, Euroland

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e-mail: ab127@uni-koeln.de

Abstract: The traditional Sznajd model, as well as its Ochrombel simplification, for opinion spreading are modified to have a convincing strength proportional to a negative power of the spatial distance. We find the usual phase transition in the full Sznajd model, but not in the Ochrombel simplification. We also mix the two rules, which favours a phase transition.

Keywords: Sociophysics, phase transition, distance dependence, quenched disorder

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Ising models have been studied since nearly one century, and simulated on computers since more than four decades. A new version is the Sznajd model [1] where again each lattice site carries a spin ± 1 . If two randomly selected neighbouring spins have the same value, they force their neighbours to accept this value; otherwise nothing is changed and a new pair is selected. In the Ochrombel simplification, instead of a pair, already a single site “convinces” its neighbours [3]. This model can be interpreted as the spreading of opinions until a consensus is reached. Instead of two values ± 1 we also can work with q values: 1, 2, ..., q .

The Sznajd model on the square lattice shows a phase transition: If initially one of the two opinions has a slight majority in a random distribution,

then at the end all spins have that value and the dynamics stops. The Ochrombel modification lost this transition [4]. We now check for this transition in the case of long-range interactions, decaying with a power law of the distance, and with a mixture of Sznajd and Ochrombel rule. The program is similar to the published one [2].

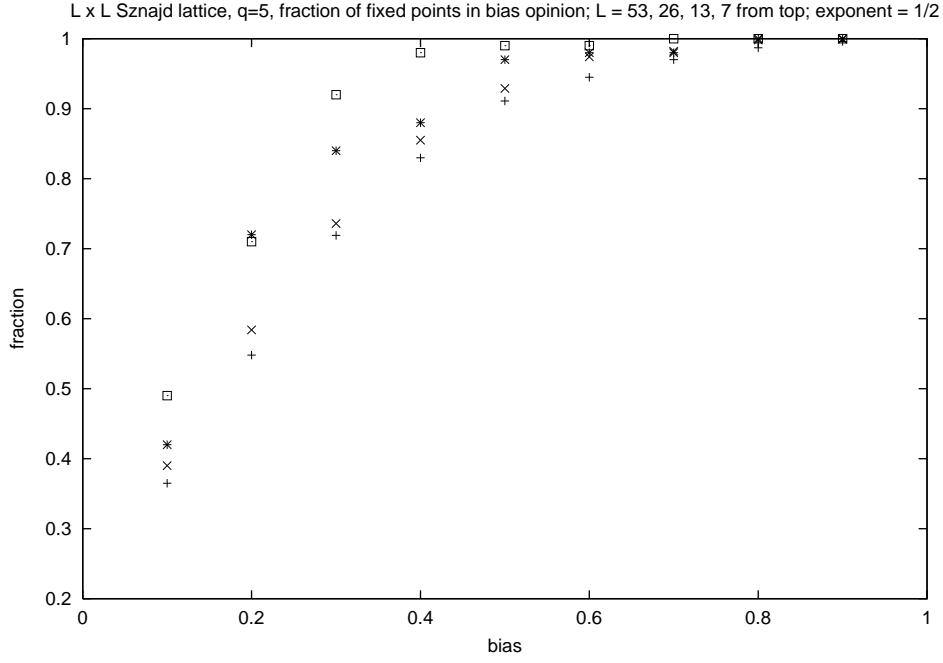


Figure 1: Fraction of successes, $L = 7$ to 53 , exponent $x = 1/2$, Sznajd case, five opinions

We made 100 or 1000 simulations for $L \times L$ square lattices with $L = 7, 13, 26$ and 53 , sometimes also 73 , usually allowing $q = 5$ values. A spin convinces, alone (Ochrombel) or together with an equally-minded neighbour (Sznajd), a neighbour at Euclidean distance R with probability $1/R^{2x}$. Initially the spins are distributed randomly among the q opinions except that with a bias probability p the just initialized spins are set to $+1$. A quenched fraction r of the sites follows the Sznajd pair rule, the remaining fraction $1 - r$ the Ochrombel single-site rule. A success is a sample where at the end all spins had the bias value $+1$.

Figs.1 and 2 show for the Sznajd case $r = 1$ the phase transition: For

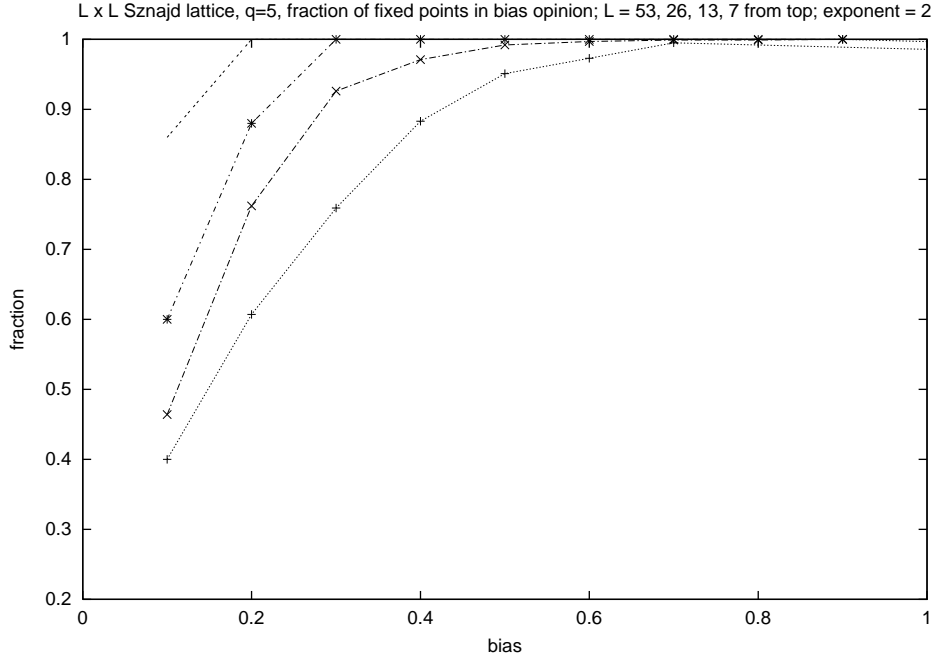


Figure 2: As Fig.1 but with exponent $x = 2$

large L a small bias p suffices to make nearly all samples successes. It does not matter much whether the interactions decay slowly ($x = 1/2$) or fast ($x = 2$) with distance. For the $r = 0$ Ochrombel case, however, analogous simulations (not shown) give no phase transition, and this situation persists even if we take a very small $x = 0.1$ (Fig.3) and reduce q from 5 to 2 (Fig.4).

Thus we mixed the two rules in Figs. 5 ($r = 0.5$) and 6 ($r = 0.1$) which show a phase transition, for $x = 1/2$, in both cases. With a faster decay, $x = 2$ instead of $x = 1/2$, the phase transition for $r = 0.1$ becomes more pronounced, Fig.7.

In summary, contrary to our expectation from thermal phase transitions, the introduction of long-range interactions instead of nearest-neighbour interactions did not create a phase transition.

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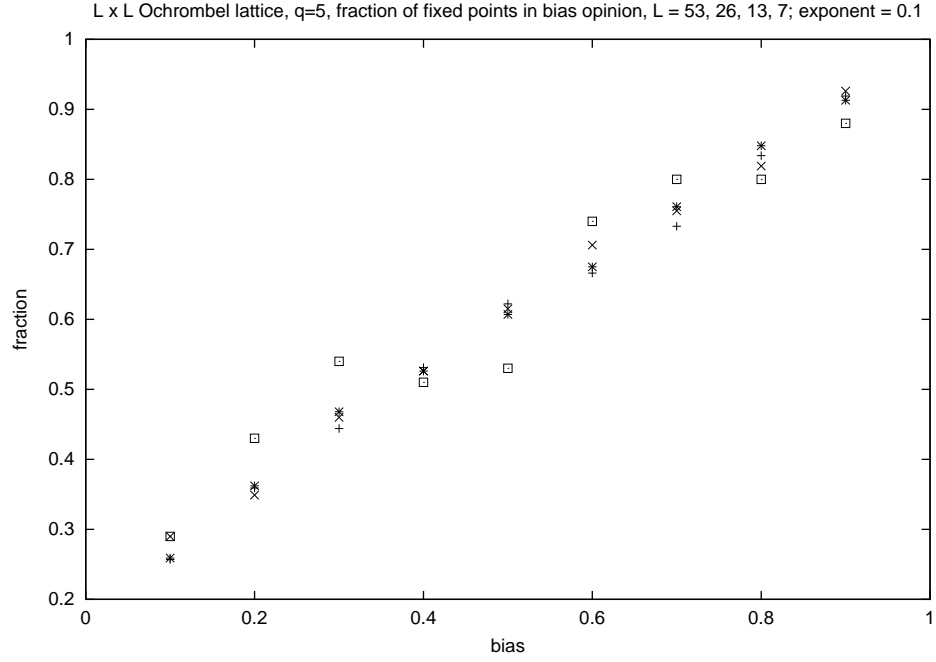


Figure 3: As Fig.1 but with exponent $x = 0.1$, Ochrombel case

References

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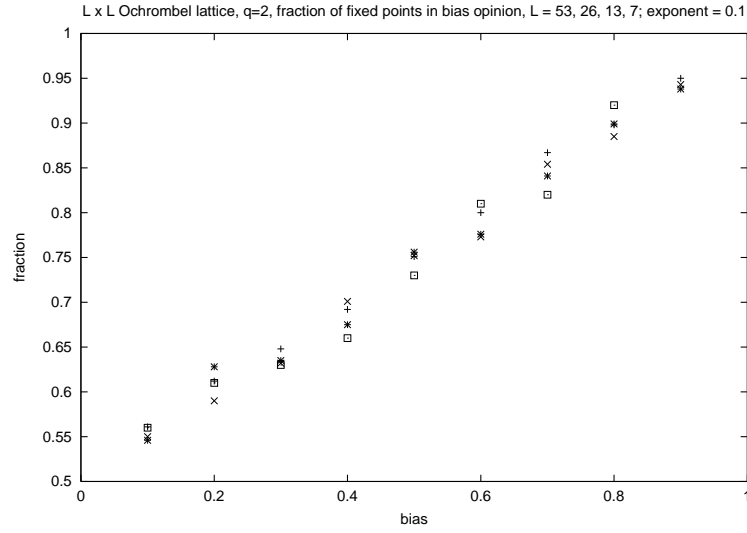


Figure 4: As Fig.3 but with exponent $x = 0.1$, two opinions for Ochrombel case

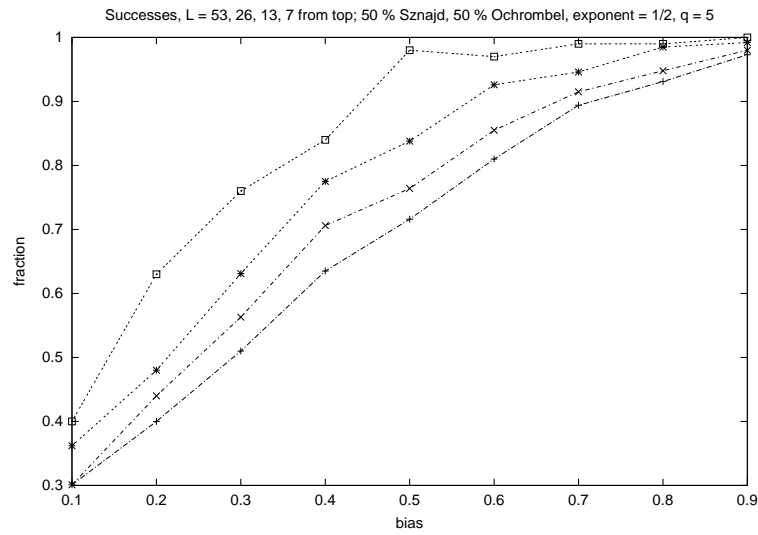


Figure 5: As Fig.1 (exponent $x = 1/2$, five opinions) for Sznajd-Ochrombel (50:50) mixture

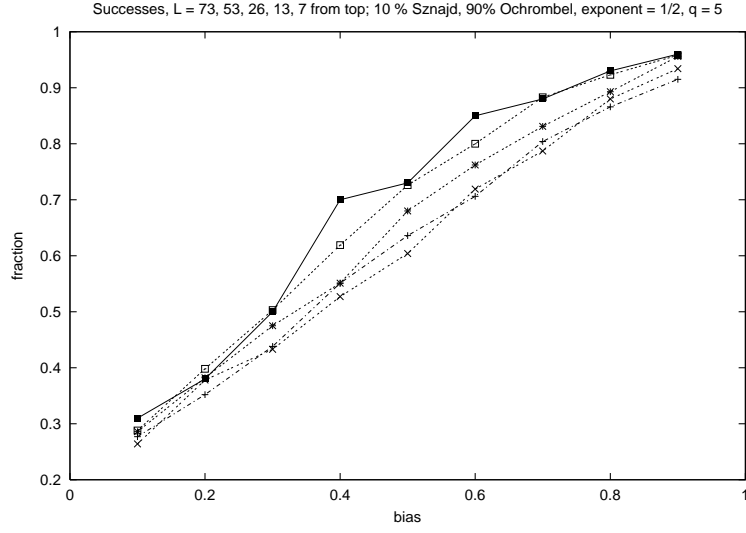


Figure 6: As Fig.5 (exponent $x = 1/2$, five opinions) for Sznajd-Ochrombel, but 10:90 mixture

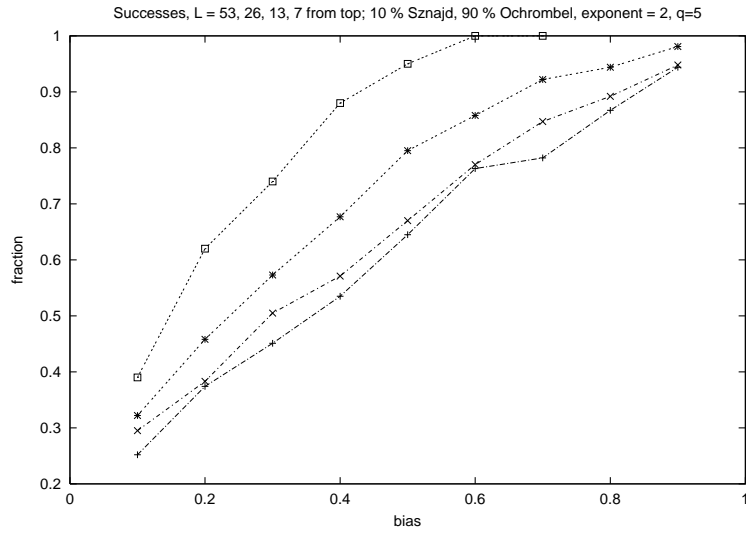


Figure 7: As Fig.6 (10:90 mixture, five opinions) for exponent 2